STATE OF ILLINOIS

DEPARTMENT OF REGISTRATION AND EDUCATION

A. M. SHELTON, *Direc or*

DIVISION OF THE

STATE GEOLOGICAL SURVEY

M. M. LEIGHTON, *Chief*

REPORT OF INVESTIGATIONS—NO. 5

STRUCTURE OF HERRIN (NO. 6) COAL SEAM NEAR DUQUOIN

BY

D. J. FISHER

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS

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By D. J. Fisher

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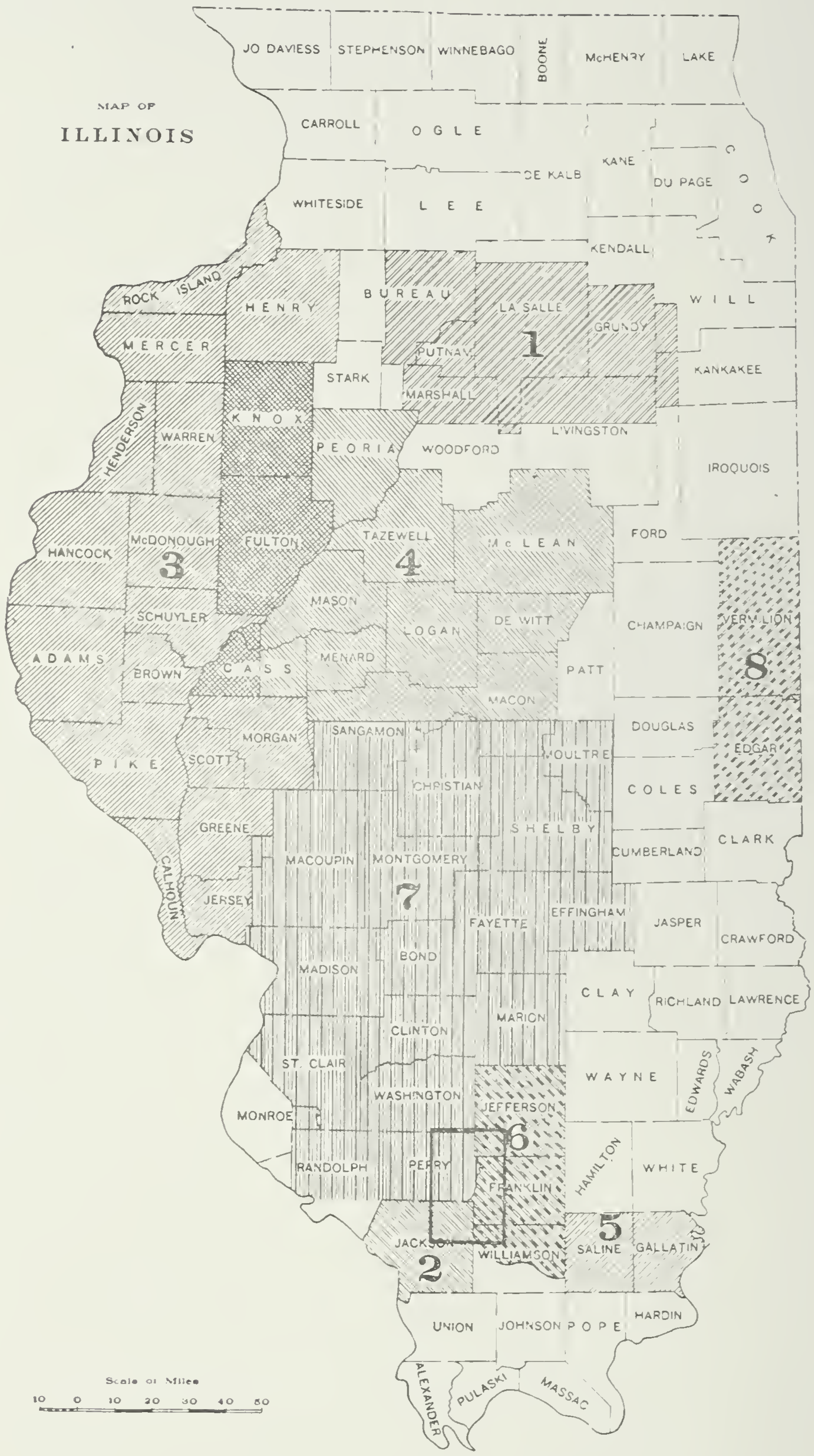


FIG. 1. Index map of the State showing the various coal districts and the area covered by this report outlined in a heavy black line.

INTRODUCTION

Location

The area covered by this report lies in the southern part of Illinois and includes portions of Franklin, Jackson, Jefferson, Perry, Washington, and Williamson counties. It is rectangular, about 28 by 17 miles, and contains 469 square miles. Figure 1 indicates its location and extent. It comprises portions of coal districts II, VI, and VII.

Object of Report

The purpose of this report is to set forth the results of a geologic study of the Herrin (No. 6) coal seam. These include the lay or amount of dip of the coal bed, and the faults, splits, and other features which interrupt its continuity. The physical characteristics and modes of origin of the coal and its enclosing beds are also briefly treated. Emphasis is placed upon the economic aspects of the geologic features.

Methods of Study

About six weeks were spent in field work during the summer of 1923, and 24 of the 29 shipping mines shown on Plate I were visited. Underground work was done in mines indicated on the map by numbers 7, 8, 12, 13, 15, 19, and 25. The results given herein are based upon observations in the mines by the writer, upon detailed study of available mine maps and logs of drill holes, and upon study of geologic work previously completed in this area. It was rare to get unconflicting data on the abandoned mines, as most of this sort of material was obtained from the older residents. The locations of some mines are probably more or less inaccurate but where maps or accurate descriptions were available, the data so obtained were incorporated in the report. The locations of abandoned mines that came to the attention of the writer are shown on Plate I, but undoubtedly others existed. No attempt is made to show the areas of the old workings, though generally they were small, few exceeding 40 acres in extent.

Acknowledgments

The advice and assistance, both in the office and in the field, of Dr. H. E. Culver, in charge of coal studies for the Illinois Geological Survey, are gratefully acknowledged. Most of the mine superintendents or engineers cooperated in this study and contributed much to the value of this report. To them especial acknowledgment is made. The extraordinary generosity of the officials of the Union Colliery

Company deserves specific mention. The writer feels under great obligation to Dr. M. M. Leighton, Chief, and to Miss H. P. C. Christensen, of the Illinois Geological Survey, for aid in revising the manuscript.

Previous Work and Bibliography

Although the area covered by the report lies in parts of three coal districts, it is nevertheless a structural unit, and as such deserves a specific report. Previous workers have been handicapped somewhat by artificial boundaries, so that a detailed study of the whole structure was impossible. The more important publications describing geologic work previously done in the area are as follows:

1. Udden, J. A., Coal Deposits near Duquoin: Ill. State Geol. Survey Bull. 14, pp. 254-262, 1909. This paper gives a short summary of earlier work in the area.
2. Shaw, E. W. and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), 1912.
3. Kay, F. H., Coal Resources of District VII: Ill. Mining Investigations Bull. 11, 1915.
4. Cady, G. H., Coal Resources of District VI: Ill. Mining Investigations Bull. 15, 1916.
5. Cady, G. H., Coal Resources of District II: Ill. Mining Investigations Bull. 16, 1917.
6. Shaw, E. W., U. S. Geol. Survey Geol. Atlas, Carlyle-Centralia folio (No. 216), 1923. Centralia is located about 20 miles north of the area described in this paper.

STRATIGRAPHY

General Statement

The consolidated rocks in the area belong to the Pennsylvanian system, which in Illinois is divided into the Pottsville, Carbondale, and the (youngest or uppermost) McLeansboro. These formations have been previously studied and described, and only pertinent facts will be reviewed here.

Origin of Strata

During the Pennsylvanian period, the surface of the southern two-thirds of Illinois was essentially flat and probably near sea level most of the time. It was subject to slow fluctuations; at times it was slightly above sea level, and at other times sea water covered much or all of the area.

FORMATION OF SHALE AND LIMESTONE

During part of the time that the sea covered the district, muds formed from the erosion of adjacent low-lying or distant high land areas were carried into the sea by streams. These muds, deposited on the bottom of the sea, were buried by other sediments, and eventually set into shales. At other times, little or no clastic material was brought into the sea and the only deposit was calcium carbonate, formed by precipitation of this substance which was dissolved in the sea water and by the secretions of animals and plants living in the sea. This deposit, when cemented into solid rock, formed the limestone. Most of the shale of the area is calcareous, indicating that calcium carbonate was being deposited more or less continuously.

FORMATION OF COAL

During much of the time that the area was above but near sea-level, it was covered by rather watery swamps out of which grew a luxuriant vegetation, somewhat similar to the present cypress swamps of some localities in the southern states. Trees and other types of vegetation lived, grew old, and on dying fell into the swampy waters that had covered the soil from which they grew. Falling underneath water, the vegetable material did not rot as it does in most of our present forests, but suffered a special type of partial decay that permitted the removal of but little of the carbon content of the wood as carbon dioxide gas. New vegetation grew on the old. In some such manner, the process continuing many thousands of years, many feet of this partially decomposed, carbonaceous, peaty material accumulated. It is conservatively estimated that about 250 feet of material such as is found near the surface of a coal swamp are needed to eventually form an 8-foot coal seam. This does not mean that at any one time there were 250 feet of water-buried vegetable matter in the area, as under such conditions the lower part would be subjected to a pressure equal to the weight of all the overlying material, which would compress the plant tissues, and squeeze out much of the water. In fact, the lower part was probably compressed to approximately one-tenth of its original thickness, even before the peaty matter was buried by other sediments.

Description of the Rocks

GENERAL STATEMENT

In the discussion of the Pennsylvanian strata the usual order of description of formations from oldest to youngest is not followed.

Because of the importance of the Herrin coal in this area that coal is described first. Then the formations below Herrin coal in descending order are taken up, after which the formations above the coal from the "cap-rock" limestone down to the Herrin coal are described.

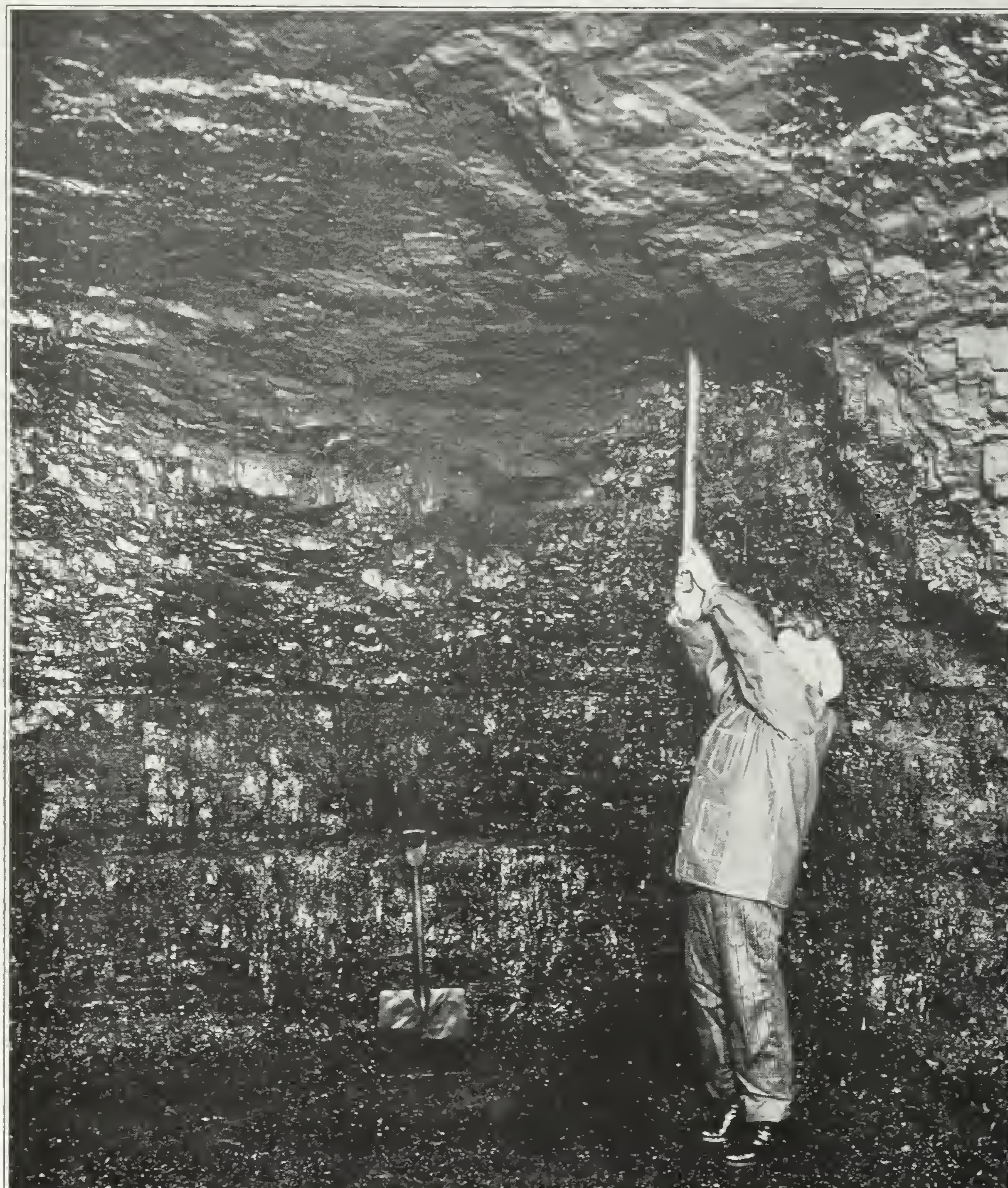


Fig. 2.—The Herrin coal in its unusual thickness of about 13 feet near Christopher. (Courtesy of Purity Coal Co.)

HERRIN (NO. 6) COAL

The Herrin coal (fig. 2) lies at the top of the Carbondale series of beds. In the Duquoin area, east of the main line of the Illinois Central Railroad this seam averages 8 to 9 feet in thickness, but west

of this railroad it probably does not average more than 6 feet. It is characterized by a dark-colored, clayey parting, called the "blue band" (fig. 3) which averages about 2 inches in thickness and generally lies 1 to 2 feet above its base. Other variations from pure coal are readily noted, but lack the great persistence and regularity of the "blue-band". The uniformity in thickness of this coal bed and the continuity of the "blue-band" over such a relatively broad area are remarkable features.

Fig. 3.—Photograph of the "blue band," a characteristic feature in the lower part of the Herrin coal.

STRATA BELOW HERRIN COAL

BEDS BETWEEN HERRIN AND HARRISBURG COALS

Below the Herrin coal (fig. 4) is found a gray clay known as "fire clay", in places as much as 10 feet thick. The thickness is greatly variable. Locally the clay is absent. This clay or in its absence, the coal, is underlain by a light gray, very fine-grained limestone, averaging about 10 feet in thickness. It contains marine fossils, among which are petrified tests ("skeletons" or "shells") of simple animals. These resemble a fairly thick grain of wheat, have a spiral cross-section, and belong to the *Fusulina* family. Below this limestone, gray shale is the dominant sediment until the next coal bed is reached. This, the Harrisburg or No. 5 coal, lies about 30 to 45 feet below the Herrin seam, although intervals varying from 15 to 50 feet have been reported.

HARRISBURG (NO. 5) COAL

Inasmuch as it was considered that a study of the Harrisburg coal bed would add little or nothing to the problem in hand, no effort

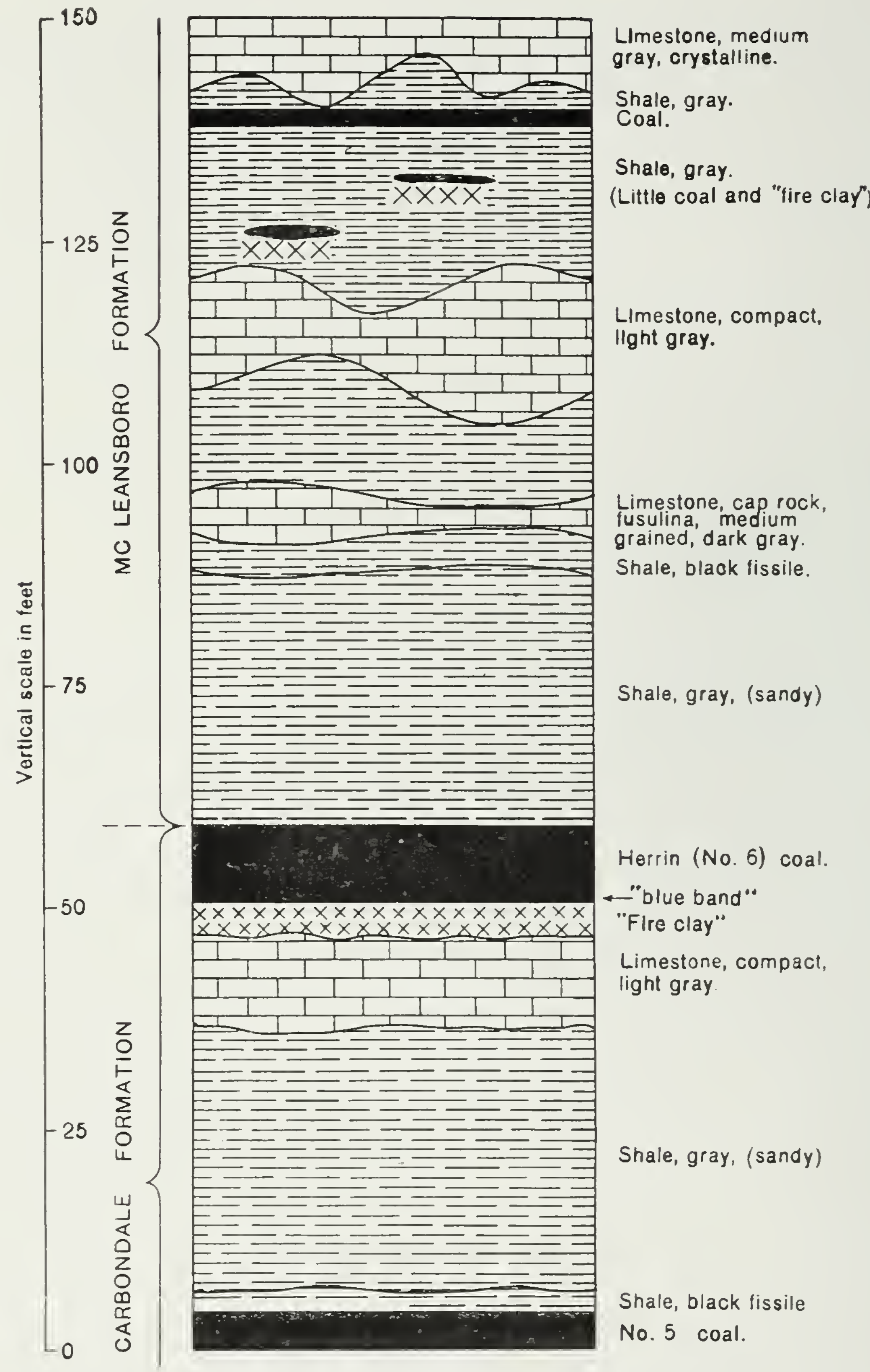


Fig. 4. Generalized columnar section showing the strata above and below the Herrin (No. 6) coal. The thicknesses shown represent the average for the thickly drilled area near Dowell.

was made to gather data on this seam. However, because of the interest shown by certain operators in the Duquoin area, the following statement is included.

So far as it is known, only one mine in the area is removing any coal from the Harrisburg seam. A small local mine operated by the Parrish Coal Company of De Soto, and located one mile northwest of De Soto in the SW. ¼ NW. ¼ sec. 17, T. 8 S., R. 1 W., is reported to be working this seam. The section shown in the shaft is as follows:

	Thickness *Feet*
Clay	20
Limestone	2
Shale	20
Limestone, dark gray	2–4
Shale, black fissile	0–1½
Coal (No. 5)	3–4

The clay at the top of this section is presumably of glacial origin. Judging from the above stratigraphic section the Harrisburg seam was probably about 40 feet below the base of the Herrin coal, before the latter was removed by erosion.

In the mine of the Jackson Coal Company at Hallidayboro, just west of the shaft and east of the main fault, an entry which is now fallen in was cut sloping to the northwest. It is reported that the Harrisburg coal was found about 50 feet below the Herrin seam. No data as to the thickness or character of the Harrisburg coal at this locality were available.

Faulting or movements in the rocks involving breakage and actual displacement of the strata has in a few cases brought the Harrisburg coal up, so that it is at or near the same level as the Herrin coal. This affords the possibility of mining both beds from the same mine level. It is reported that in the south part of the Kathleen mine at Dowell, the easternmost fault in NE. ¼ sec. 8 (Pl. II) with upthrow on the east side has brought the Harrisburg coal up, so that it appears in the face of entries 9-10 E. off the main south entry cut in the Herrin coal.

Figure 5 is a sketch map of the Duquoin area showing the locations of the drill holes which reach the level of the Harrisburg coal. The holes in which this seam is absent or not thicker than 2 feet are indicated by a different symbol from those in which it is at least 3½ feet thick. In most holes the thickness is 4 to 5 feet. One log of a hole near St. John shows 6 feet; one near Waltonville, 7 feet. Data from the logs of about 50 holes in the area show the average thickness of the Harrisburg coal to be 4½ feet and the average depth below the Herrin seam to be 35½ feet.

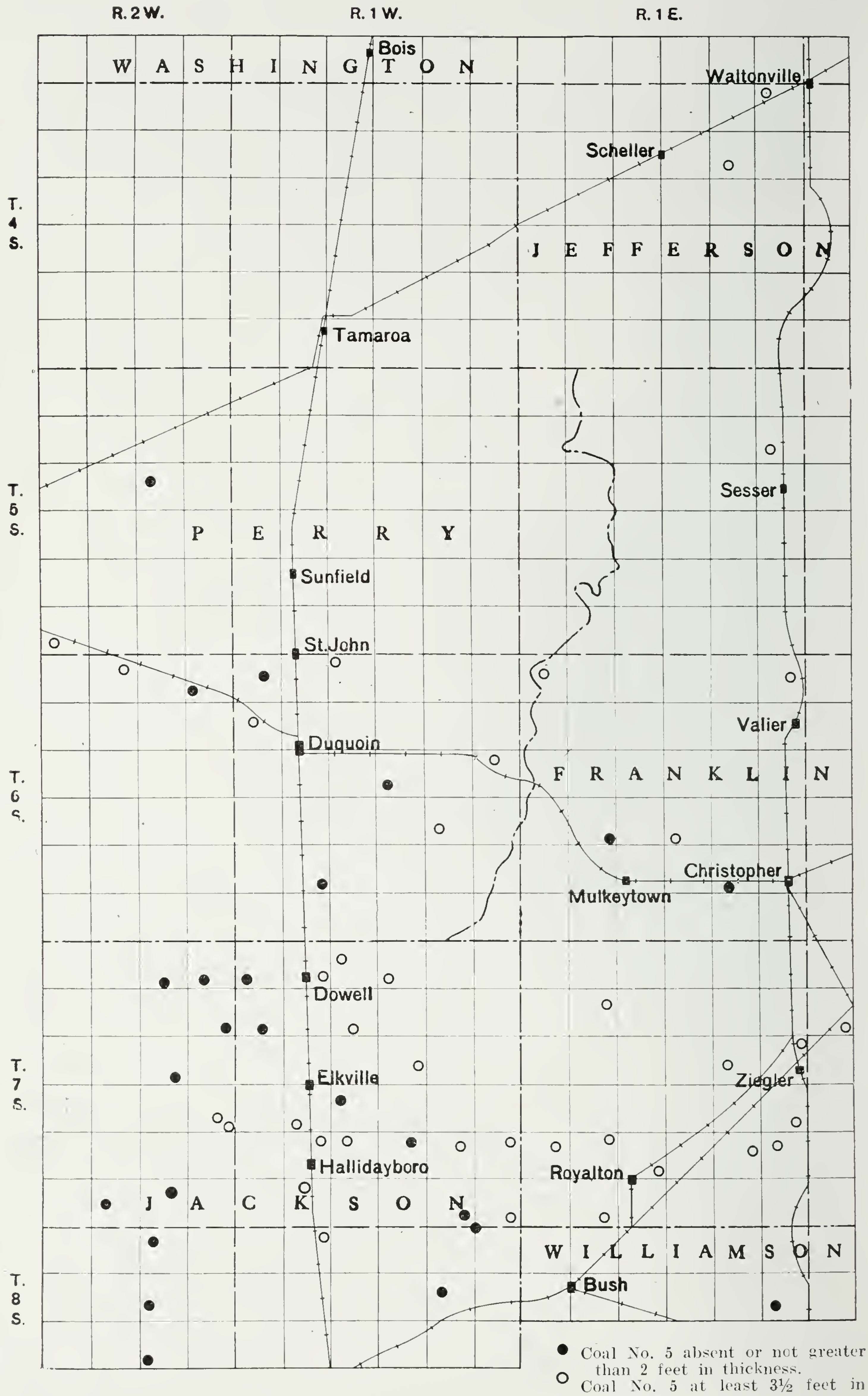


Fig. 5. Map of the Duquoin area showing the locations of drill holes which reach the level of the Harrisburg (No. 5) coal seam. Scale, 4 miles equal one inch.

STRATA ABOVE HERRIN COAL

THE "CAP-ROCK" LIMESTONE

Above the Herrin seam (fig. 4) in the McLeansboro formation, the most important key stratum close to the coal in this area is a fairly persistent thick-bedded limestone locally known as the "cap-rock." It has a medium-fine texture, is of a very dark gray color on the fresh surface weathering to a light brown, and contains marine fossils, among which are *Girtyina ventricosa* as determined in the field by H. E. Culver, a Fusulina smaller than the forms found in the limestone below the Herrin seam in this region. This "cap-rock" limestone formed in a shallow marine embayment, having low lying islands, or an irregular shore-line extending into the Duquoin area. This is indicated by the somewhat lenticular character of the rock as shown by the logs of drill holes. Other apparently lenticular limestone horizons occur slightly above the "cap-rock" limestone. It would seem unlikely that the apparent lenticular character of all these limestone horizons would be due to partial erosion of each of them.

One of the cores drilled near Dowell over 200 feet in depth showed no limestone above the Herrin coal. Another showed only 6 inches of limestone. Others contained as many as three limestone formations. Study of the cores of 25 holes drilled by the Union Colliery Company near Dowell furnished data for the following table:

TABLE 1.—*Summarized data regarding the thickness of several limestones and the intervals between them and the Herrin coal.*

Limestone	Average thickness	Average distance of base of limestone above the top of the Herrin coal
	Feet	*Feet*
3. Medium-gray, crystalline	8	82
2. Light-gray, compact	12½	49
1. "Cap-rock" limestone	5	33

In the Duquoin area the maximum known thickness of the "cap-rock" limestone is 12 feet, but it averages 4 to 5 feet. It is not known to be more than 100 feet above the Herrin coal, and is generally found between 30 and 50 feet above it.

STRATA BETWEEN THE "CAP-ROCK" LIMESTONE AND THE HERRIN COAL

The "cap-rock" limestone is commonly underlain by 2 to 6 feet of black fissile shale known as "draw slate" which contains marine

fossils. The strata between this and the Herrin coal are mainly of gray, somewhat sandy shale. In places this shale is thin; locally it is absent.

Thus at the strip pit of the Black Servant Coal Company one mile west of Elkville the "cap-rock" limestone which is 5 to 6 feet thick rests on 3 or 4 feet of black fissile shale which immediately overlies the Herrin coal. In the Jackson Coal Company mine at Hallidayboro, along the main west entry at the fault just west of the shaft (see fig. 11), the "cap-rock" limestone is about 10 feet thick and in places is separated from the Herrin seam by only 8 feet of shale, the upper half

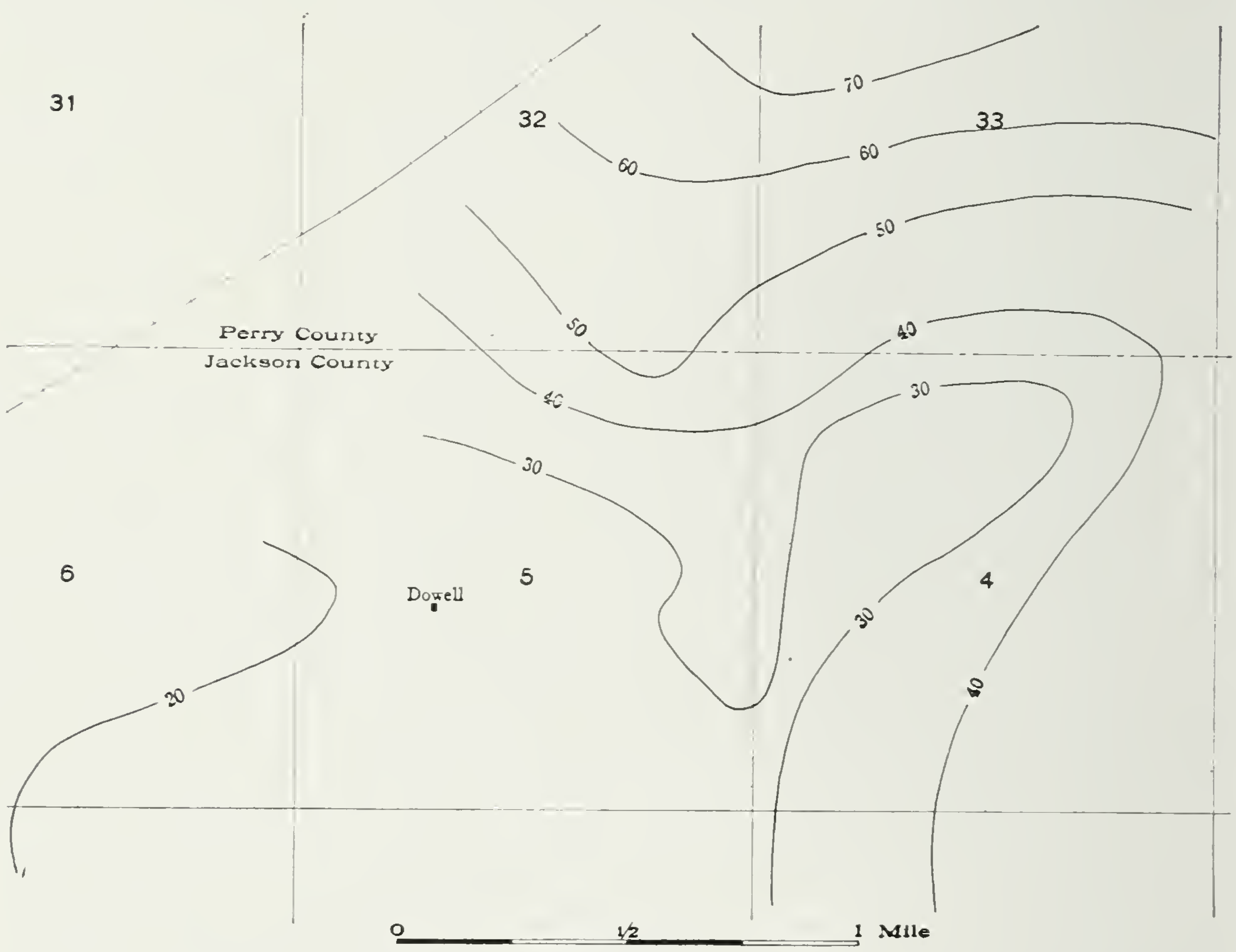


Fig. 6. Convergence map showing interval in feet between the base of the "cap-rock" limestone and the top of the Herrin coal. Secs. 31, 32, and 33 in T. 6 S., R. 1 W. and secs. 4, 5, and 6 in T. 7 S., R. 1 W.

of which is of the black fissile type. The lower surface of the limestone is somewhat contorted. These contortions are apparently the result of roll-like disturbances in the underlying shale, and help explain the variable thickness of the limestone. Three miles farther north, half a mile south of the shaft of the Kathleen mine at Dowell, the "cap-rock" limestone is 23 feet above the top of the Herrin coal. North of the shaft the thickness of the strata between the Herrin coal and the "cap-rock" limestone increases rather rapidly, as is shown by

the convergence map, figure 6. The lines connect points having constant interval between the limestone and the coal, and have the values indicated by the figures on the lines. Four miles northeast of Dowell, at the Majestic Mine of the Equitable Coal and Coke Company, this interval is almost 100 feet.

The variation in thickness of the strata between the Herrin coal and the "cap-rock" limestone seems best explained on the basis that the vegetable matter which later became the Herrin coal accumulated on an irregular surface. That such a surface, probably due to erosion, existed is indicated by the fact that the Herrin coal rests on "fire clay" of variable thickness or even directly on the underlying limestone. Moreover, while the interval between the Harrisburg and Herrin coals is rather uniform so far as known throughout the Duquoin area, 15 miles east of Herrin it is much greater, averaging about 100 feet.[1]

Where now there is a belt of thick coal along the eastern side of the Duquoin area, the "cap-rock" limestone is farther above the Herrin coal than is common elsewhere. When the Herrin coal swamp first existed along this belt there was probably a gentle valley-like depression. In this, conditions were such that vegetable material accumulated more rapidly than it did on the surrounding slightly higher land. Thus when the lake or arm of the sea in which was deposited the clayey material now making up the "blue-band" first came into existence, there was a greater thickness of a peaty material present in the lower belt. Therefore now the "blue-band" is found farther above the base of the coal in the belt of thicker coal.

Somewhat later, coal-forming conditions again prevailed, and a greater thickness of peaty material accumulated in the lower area as before, until the surface of the swamp was probably nearly level. As a result of this irregular accumulation of peaty material, thicker in the trough than elsewhere, the greatest shrinkage of the peat took place in the trough when the overlying muds were deposited. This permitted a thicker accumulation of mud here than elsewhere before the material forming the "cap-rock" limestone was deposited.[2]

Limits of the Area Underlain by the Herrin Coal

Accuracy of the Boundary Line

The line across the southwestern part of the map, Plate I, indicating the western boundary of the Herrin coal seam represents an approximation, except west and southwest of Elkville, where drilling

[1] Cady, G. H., Coal Resources of District VI: Ill. Mining Investigations Bull. 15, Plate IV, 1916.

[2] Idem, pp. 30-32.

by the Black Servant Coal Company has resulted in its accurate delimitation.

ABSENCE OF COAL IN REGION

AREA OF POSSIBLE NON-DEPOSITION

There are two large parts of the Duquoin area which have not been sufficiently tested by drill holes. These are in the whole northern and northwestern portions of the area (Pl. I) and in a large area centered near Mulkeytown, covering much of the western part of Franklin County, but especially pronounced to the west of Sesser and Valier. In the northern portion of this Mulkeytown area the logs of three drill holes show no Herrin coal, indicating the possibility of non-deposition of this seam here. However, since a large portion of the northwestern part of Franklin County has not been drilled so far as known, no definite statement can be made concerning this area. The theory sketched in the preceding paragraphs implies the existence of a thick seam of coal in this area.

AREAS OF SUBSEQUENT EROSION

Less than one mile east of the main line of the Illinois Central Railroad near Duquoin, two elongate north-south areas are shown on Plate I from which it is considered that the Herrin coal has been removed by erosion. One of the early Pleistocene ice-sheets is responsible in part, though some of this missing coal was probably removed in earlier epochs. Because the coal seam was so high in these areas, the protecting cover of sediments as well as the coal were removed by weathering and erosional processes. North of St. John, the boundary of the northern area is unknown, though it is indicated by a doubtful line.

STRUCTURE

Structural Features Developed Before or During Consolidation

SPLITS

GENERAL STATEMENT

Wherever a coal seam is divided into two or more parts by one or more layers of another rock called partings, the seam is said to be split. The term is generally applied only where the parting is biconvex, like a large, very thin lens. A split was probably caused by the incursion of mud-bearing waters which temporarily and more or less locally interrupted the coal-forming process. Splits are important from the economic viewpoint because they prevent extraction of the

coal under present economic conditions even though they do not influence the grade or quality of the coal.

Besides splits the coal has other structural features that were not formed subsequent to consolidation. Although in the main the various strata were at one time all essentially horizontal, minor depositional dips or grades were no doubt originally present. These, and such minor structures as rolls that developed at least in part during the consolidation of the loose sediments into solid rocks, are not considered further in this report.

THE MAPPING OF SPLIT AREAS

The areas of split coal are shown on Plate I by shading in black. The degree of accuracy of the boundaries are indicated by solid lines, by omission of definite boundary lines, and by the insertion of question marks to show whether the boundaries are certain, rather doubtful, or quite problematical, respectively.

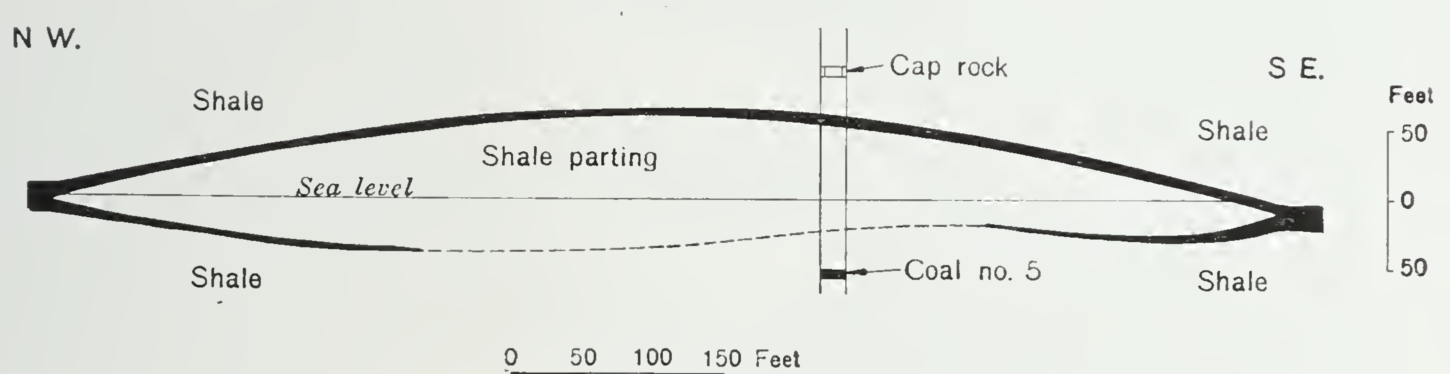


Fig. 7. Diagrammatic cross-section of split just southeast of shaft of Majestic mine.

It is probable that patches of unsplit coal of workable thickness exist in the large area of split coal outlined around Mulkeytown. Many sections in this area have never been drilled, so far as it is known. Nine holes, each drilled in a different section, southeast, south, and southwest of Mulkeytown and none over four miles from town are not shown on Plate I since the logs were not obtainable, although it was reported that they all showed a coal seam unfavorable for mining under present economic conditions. The boundaries shown for the south and east sides of this area are particularly questionable.

DETAILED DESCRIPTIONS OF AREAS OF SPLIT COAL

Majestic mine.—An excellent example of a split has been completely delimited in the workings of the Majestic mine. The outline of the split appears on Plate I in the W. ½ of sec. 23, T. 6 S., R. 1 W. a short distance southeast of the shaft. Figure 7 shows a diagrammatic cross-section compiled from data obtained from a study in the

mine and the log of a drill hole which penetrates the split area. Figure 8 shows a large-scale diagram of the north side of this split as it appears in one cross-section. The thicker part of the seam generally follows the upper side of the shale parting in the Majestic mine, although the opposite is true at the place represented in figure 8. The diagram illustrates the fact that the bedding in the coal runs parallel to its surfaces in this split, and the dip of the split coal near the edge averages about 10°.

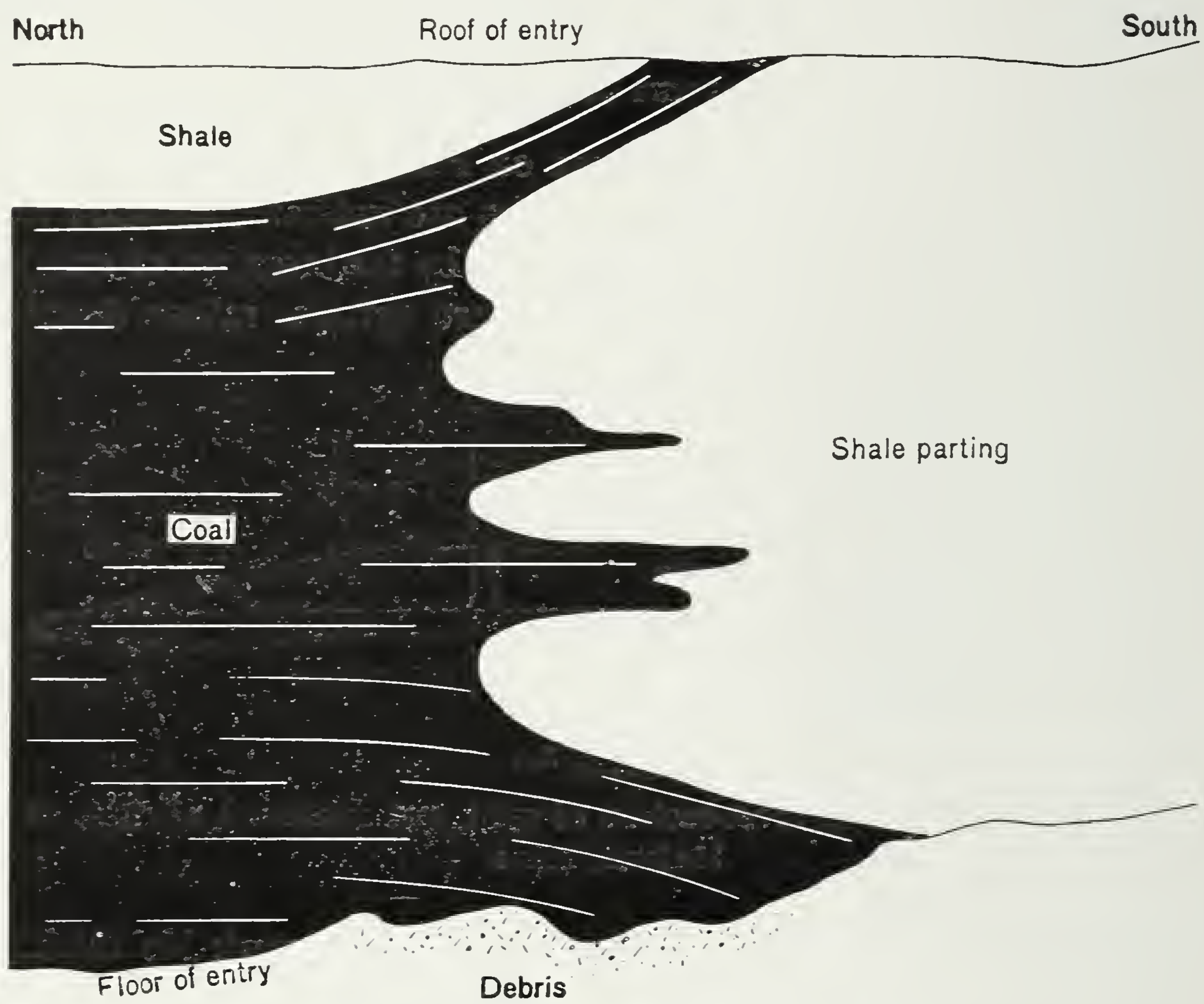


Fig. 8. Detail of north side of split, Majestic mine (E. rib, entry 8 S., main E.). Scale, 1 inch equals 2.8 feet.

The west side of a larger split has been delimited in the eastern part of the Majestic mine, and is shown on Plate I in the extreme east-central part of sec. 23, T. 6 S., R. 1 W., about one mile east of the shaft. The thicker part of the seam rises steeply here; entries have been driven on as high as a 30 degree pitch for short distances in this thick upper part. The area of this split is unknown, as the location of its eastern boundary has not been determined precisely, but it seems probable that it is not much larger than half a square mile in area at the most, as in this district known splits which cause steeply-dipping coal beds are not large.

Mulkeytown area.—In the northwestern part of sec. 15, T. 6 S., R. 1 E., in the western part of the Old Ben Coal Corporation mine No. 11, the workings have delimited what appears to be the northeast corner of a larger area of split coal. The parting starts with almost paper-thinness near the middle of the 8-foot coal seam along entry 9 W. off 4 N. off the main west. Farther west it increases very gradually in thickness until at the end of the entry, a total distance of 650 feet, it is about 2 feet thick. The parting is medium-gray shale containing a little fine sand. The blue-band, which is about 4 inches thick, persists near the middle of the lower part of the seam. On incomplete evidence it seems probable that this split area is but a small fraction of a much larger area of split coal, as indicated on Plate I. This area apparently includes Mulkeytown, the southern part of Christopher, and a broad area southwest and west of Christopher reaching within two miles of Zeigler, Royalton, Elkville, Dowell, and Old Duquoin.

Hallidayboro-Bush area.—What seems to be a separate area of split coal is outlined on Plate I between Hallidayboro and Bush although the area may be a locality in which the "blue-band" is excessively thick. Evidence in favor of this conception appears in the eastern part of the Jackson Coal Company mine at Hallidayboro in NW. ¼ sec. 29, T. 7 S., R. 1 W., where the "blue-band" is reported to increase considerably in thickness, averaging about 18 inches. The most pronounced feature of this area is the basin shown by structure contour lines in the NE. ¼ of sec. 27, T. 7 S., R. 1 W. It seems probable that this notable structural depression is at least in part due to a split, the contours being based on the lower part of the seam.

ORIGIN

No one mode of origin will account satisfactorily for all these various types of splits, although they were formed at the same time that vegetable matter later converted into Herrin coal was accumulating in the neighborhood. During the latter stages of the Carbondale epoch, when most of the area was a swamp in which a luxuriant vegetation grew, due to small irregularities in the surface of the land, temporary lakes or ponds were present in certain localities. The split area completely outlined in the Majestic mine marks the site of one such pond near the close of the Carbondale epoch. After a certain amount of vegetable matter had accumulated at this place, which as indicated in figure 7 was probably marked by a depression in the underlying rocks, physical conditions changed sufficiently so that mud was carried into the pond that already existed there or was formed at that

time. If a pond existed previously, it was so shallow as to offer no real impediment to the growth of vegetation. Possibly the mud was carried in by a stream and dropped as a delta deposit, notably compressing the vegetable matter. That this split is a deposit of the delta type is suggested perhaps by its small area, about 20 acres, and its relatively great thickness, probably over 50 feet.

The split partially outlined in the eastern part of the Majestic mine may also be of the delta type as it is probably of limited extent.

On the other hand, the split discovered in the northwestern part of the Old Ben Coal Corporation mine No. 11 near Christopher seems to be a typical lake or sea deposit. Its gradual increase in thickness indicates a relatively thin deposit over a rather broad area. While it is mapped as part of the large Mulkeytown split area, it seems certain that no lake or arm of the sea covered the whole area at one time. This is indicated by the fact that no single shale parting appears to be represented in the different drill hole logs throughout the area. In fact, in some cases several partings appear in a single drill hole log, showing that mud deposits formed in several ponds or lakes that were not contemporaneous. It seems probable that locally these deposits do not overlap, and workable coal might then be present in certain restricted patches of the large Mulkeytown split coal area.

The other area of split coal, that lies between Hallidayboro and Bush, is in part a lake or sea deposit of the type just described. If the structural depression shown on Plate I in the NE. ¼ of sec. 27, T. 7 S., R. 1 W., is caused by a split, it would seem to resemble the type described in the Majestic mine, and conceivably might represent an old delta deposit.

Structural Features Developed after Consolidation

GENERAL CONSIDERATIONS

The rocks of the Duquoin area have been slightly disturbed subsequent to their formation. While as originally deposited and changed by consolidation, certain types of structures were present, such as rolls and splits, subsequent forces have produced much more pronounced irregularities. The coal seam, once essentially continuous, has locally been faulted; that is, broken and displaced or offset along a more or less irregular surface, the fault plane. In addition, the whole area has been gently warped and now is a part of the large structural basin of Pennsylvanian rocks which covers the southern two-thirds of Illinois, and adjacent parts of Indiana and Kentucky. The strata of the Duquoin area have a prevailing northeasterly dip towards the center of the basin, except where minor forces have produced local modifications.

STRUCTURE CONTOURS

The structure in an area of gently dipping rocks such as near Duquoin is best shown by means of structure contours, although cross-sections, block drawings, sketches, and photographs are also of value. Structure contours afford an accurate representation of structural conditions; other methods of showing structure are likely to exaggerate the actual conditions.

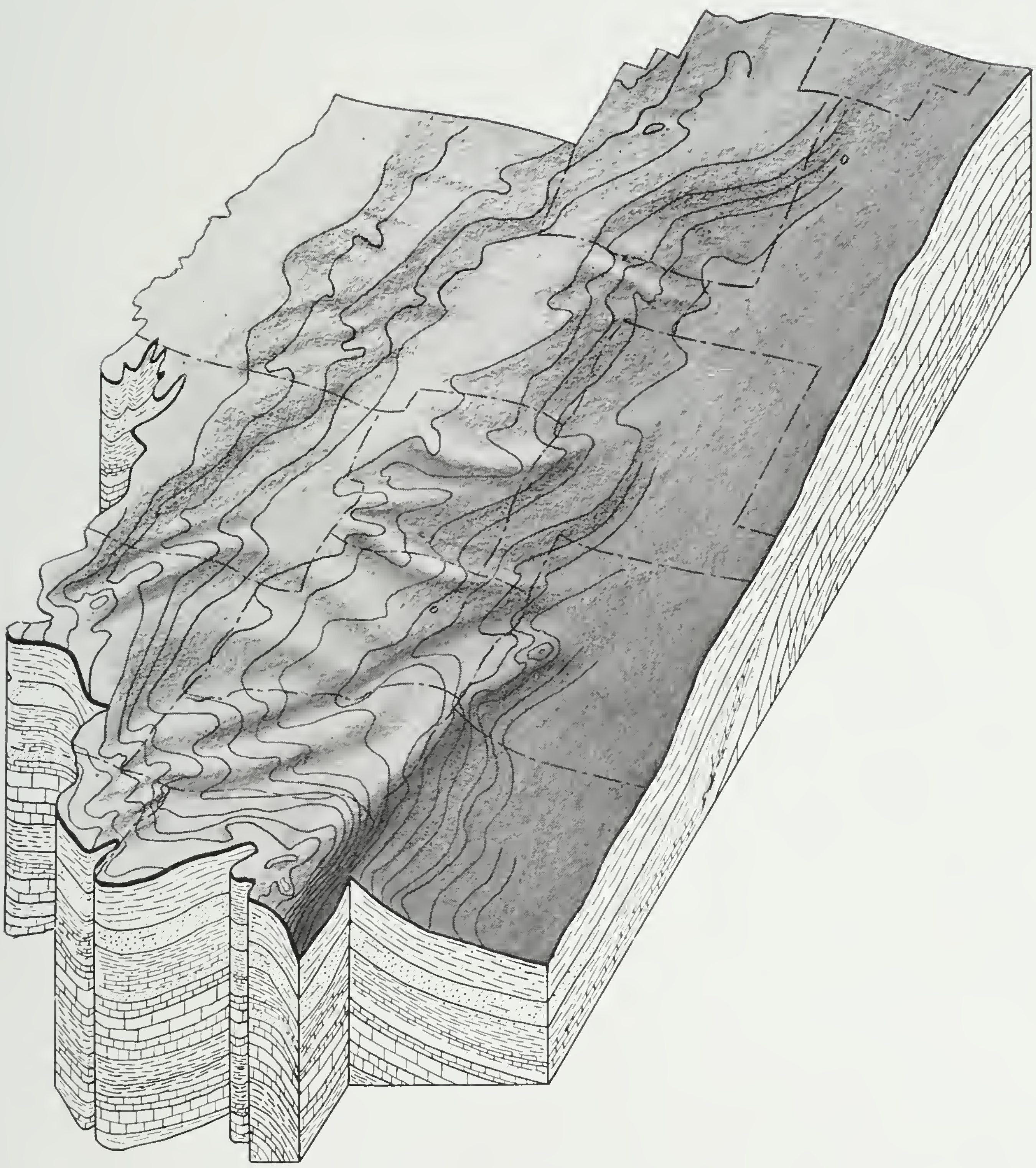


Fig. 9.—Surface of the Herrin coal as it would appear if all the overlying material were removed. The diagram shows the significance of the structural contour line. (Shading by George H. Renshawe.)

Contours are lines drawn connecting points on any surface that have the same altitude. This surface may be the land surface, or it may be a buried surface, such as the top or base of a coal seam. In the case of a buried surface, the lines are known as structure contours. Figure 9 by Fred H. Kay makes clear the use of structure contours.

County boundaries are sketched on this diagram; part of Franklin County is shown in the lower right-hand corner. The vertical distance between successive contour lines, known as the contour interval, is arbitrarily chosen. In figure 9, this is 50 feet. On Plate I it is 20 feet except in the northwestern part of the map, where for lack of sufficient data an interval of 100 feet is used. The surface shown by structure contours on Plate I is the base of the Herrin coal or the top of the underlying beds. This was chosen in preference to the top of the coal, because mine maps generally show elevations along the floors of the entries, which practically correspond to the base of the coal bed. Where the contours are closely spaced, this surface has a relatively steep inclination; where far apart, it is nearly horizontal.

ACCURACY OF THE STRUCTURE CONTOURS

The accuracy of the structure contours on Plate I depends mainly upon: (1) the accuracy of the base maps used; (2) the number and distribution of the drill holes whose logs are used; (3) the accuracy of the logs; (4) the accuracy of the figures obtained for the elevations of the surface at the locations of the drill holes; and (5) the accuracy of the elevations shown on the mine maps used.

As topographic maps were not available for the northern half of the area, there was considerable uncertainty in locating and obtaining the surface elevations of some holes in that part of the area. In the north-central and northwestern parts, structure contour lines are either not shown, or else the contour interval is increased to 100 feet due to the paucity of both mines and available drill hole logs. The absence of contours does not indicate lack of coal.

In general structure contours are less accurate than surface contours, because the data from which they are prepared are less complete. Data from drill hole logs and other sources give the elevation of the base of the coal seam at a limited number of points. Contours are then drawn which are in harmony with these values, but minor irregularities in the coal seam are generally not shown on the map. Solid lines indicate very accurate data taken from levels on mine maps; long dashed lines show doubtful or somewhat scattered data; and short dashed lines are in more or less speculative positions.

WARPING

DUQUOIN MONOCLINAL FLEXURE

The most pronounced feature modifying the general north-easterly dip characteristic of the rocks of the area is the Duquoin monoclinal flexure trending N. 10° E. from Elkville past Dowell and one

mile east of Duquoin. This is clearly shown in figure 9. Previous authors have commonly referred to this as an anticline, but it is more accurate to call it a monoclinal flexure, since in general opposing dips are absent and the dip is rarely greater than 5° to 6°.

The Duquoin monoclinal flexure is shown on Plate I by the closely-spaced contours drawn on the base of the Herrin coal seam. It is especially marked between Dowell and an area about two miles east of St. John, from where it appears to broaden out to the northward gradually, though accurate data are lacking in this area. It can be traced, however, as far north as the Sandoval dome a few miles north of Centralia. South of Elkville or Hallidayboro it loses its monoclinal character, and the contours bend off in a southeasterly to easterly direction conforming to the general regional dip.

Except in areas of split coal the maximum dip observed in the strata of the Duquoin monoclinal flexure was 8¼°, which is equivalent to a grade of 14½ per cent. The average easterly dip of the strata on this flexure in T. 6 S., R. 1 W. where it is best developed is about 5° or an 8¾ per cent grade.

FAULTING

GENERAL CHARACTER OF THE FAULTS

Most of the faults in the Duquoin area are of the normal type; that is, the fault plane dips toward the downthrow side as in figure 11. In general, therefore, where the coal seam is lost at a fault plane the rule is to follow the fault plane in the direction of the obtuse angle between the coal seam and the fault plane in order to reach the lost part of the seam. Where the fault plane makes an angle of 45° to 50° or less with the horizontal as in figure 12, the fault is likely to be of the reverse type. In this case the fault plane dips toward the upthrow side, and in order to find the hidden part of the seam it is necessary to follow the fault plane in the direction of the acute angle. Fault planes do not extend indefinitely in any direction. From a place of maximum vertical displacement the amount of offset generally decreases in both directions along the fault line. Although there is a general decrease, in most cases this is not uniform; the displacement in a given direction while decreasing on the whole may actually increase locally.

SYSTEMS OF FAULTING

Faulting in the area so far as known is confined to two belts or systems. One trends about N. 10° E. parallel to and along the east side of the Duquoin monoclinal flexure (Pl. I). The other trends

east-southeasterly through Hallidayboro and Royalton. The former system contains faults whose individual trends correspond with the trend of the system; in the latter system, which is the wider, the faults are mainly short cross-faults that trend south-southeast roughly at 45° to the direction of the system. It is to be noted, however, that the two faults showing the greatest amount of displacement which are shown on Plate I lie in this second system and trend approximately parallel to the direction of the system.

The N. 10° E. system appears to be short; there is no evidence that it extends beyond the limits of Plate I. Its close association with the Duquoin monoclinal flexure suggests that both structures were produced approximately at the same time as a result of the same forces. There is no evidence that lateral compressive forces were of more than minor importance. A gradual settling of the beds on the east side of the flexure accompanied by minor faulting, in part of the graben type, appears to offer a simple yet logical explanation of the present structure.

The other system, however, is apparently a part of the "east-west fault zone" described by Cady[3] in coal district VI to the east. Cady shows the system trending about S. 70° E. Extended in a westerly direction, Cady's "east-west" fault zone would include Dowell. It is possible that the fault mapped by Shaw and Savage[4] in the northwestern part of the Murphysboro Quadrangle also belongs in this system.

It seems probable that a cross-pattern of minor faults may lie at the juncture of these two fault systems. The logical area in which to expect such a fault pattern is immediately to the northeast of Elkville, where the closely-spaced contours (Plate I) bend sharply to the southeast. Data to prove the existence of such faults are not available, though recent development work in the southern part of the Kathleen mine near Dowell has uncovered a fault trending S. 15° E. which seems to be a curved extension of one of the N. 10° E. faults so common in the mine.

DESCRIPTION OF THE FAULTS

Faults near Weaver.—The largest measured fault in the area is the one trending ESE. in Old Ben Coal Corporation Mine No. 20 near Weaver, Williamson County. As this mine was closed in the

[3] Cady, G. H., Coal Resources of District VI: Ill. Mining Investigations Bull. 15, p. 82, 1916.

[4] Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), 1912.

summer of 1923 no underground studies could be made. It was reported that where the main NW. entry strikes the fault plane, the coal seam has a downthrow of about 44 feet, as shown by a drill hole a short distance beyond the end of the entry. On the south side of the fault plane for a short distance the coal dips 3½° to the south along the entry. The other faults in this mine are much smaller, the next largest one having a maximum known displacement of 22 feet. This was measured in the NW. ¼ of the NE. ¼ of sec. 2, T. 8 S., R. 1 E., along entry 3 W. off the main N. To the southeast this fault disappears in slightly less than one mile. Its extension to the northwest is unknown. The other faults in this mine (Plate I) have maximum throws of about 10 feet. So far as is known, all are of the normal type.

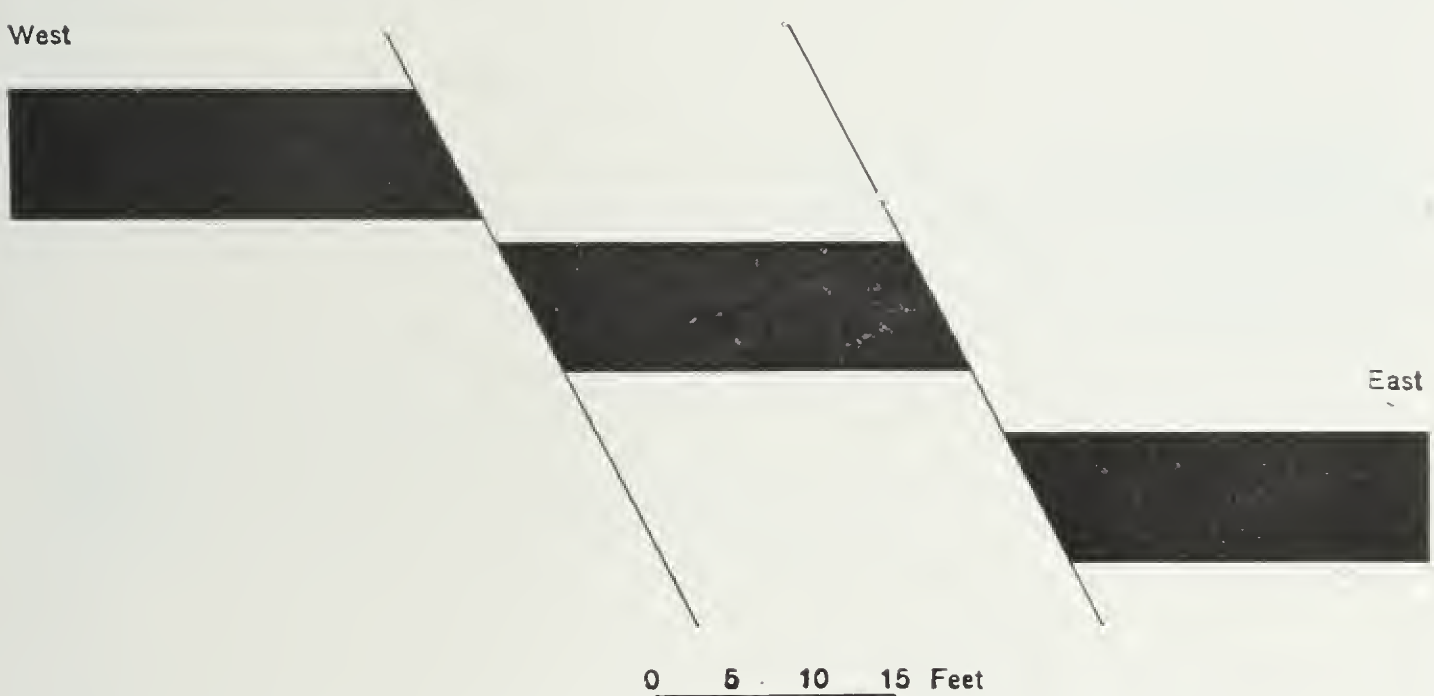


FIG. 10. Cross-section (looking north) of main fault in No. 2 mine at Bush.

Faults Near Royalton.—It was impossible to see the fault that separates the two Royalton mines, but it was described as consisting of a series of parallel slips with a total downthrow of about 40 feet on the southwest side. The coal bed dips gently to the northeast on both sides of the fault zone; on the northeast side it is very gentle; on the other side it is slightly steeper, except just at the fault where it is at a relatively high angle.

This belt of steeply dipping beds to the northeast is too narrow to be shown by contours on a map the size of Plate I; thus the large throw of this fault is not indicated.

There is only one fault of much importance exposed in the workings of Mine No. 2 of the Western Coal and Mining Company in the SE. ¼ sec. 31, T. 7 S., R. 1 E., approximately one mile north of Bush. It is the one shown by dashed lines on Plate I curving in a northerly direction. It is a normal fault with the downthrow on the east side.

Where the 1-2 E. entries off the main N. intercept the fault, the throw is but 10 feet; but about 1100 feet farther northwest, where the 3-4 E. entries off the main N. intercept it, the throw is 21 feet. The 5-6 E. entries off the main N. end at the fault plane. It appears that the throw along this plane increases to the north, where it may become as much as 50 or 60 feet. In cross-section along the 4 E. entry off the main N., this fault (fig. 10) is double, and the two planes are about 30 feet apart.

Extending northeast from this fault is postulated a short fault with a maximum throw of about 60 feet with downthrow on the northwest. Extending in a northwesterly direction is shown on Plate I a possible fault with a maximum downthrow on the northeast side of about 100 feet. It appears to die out in Jackson County. These two hypothetical faults are based on drill hole records.

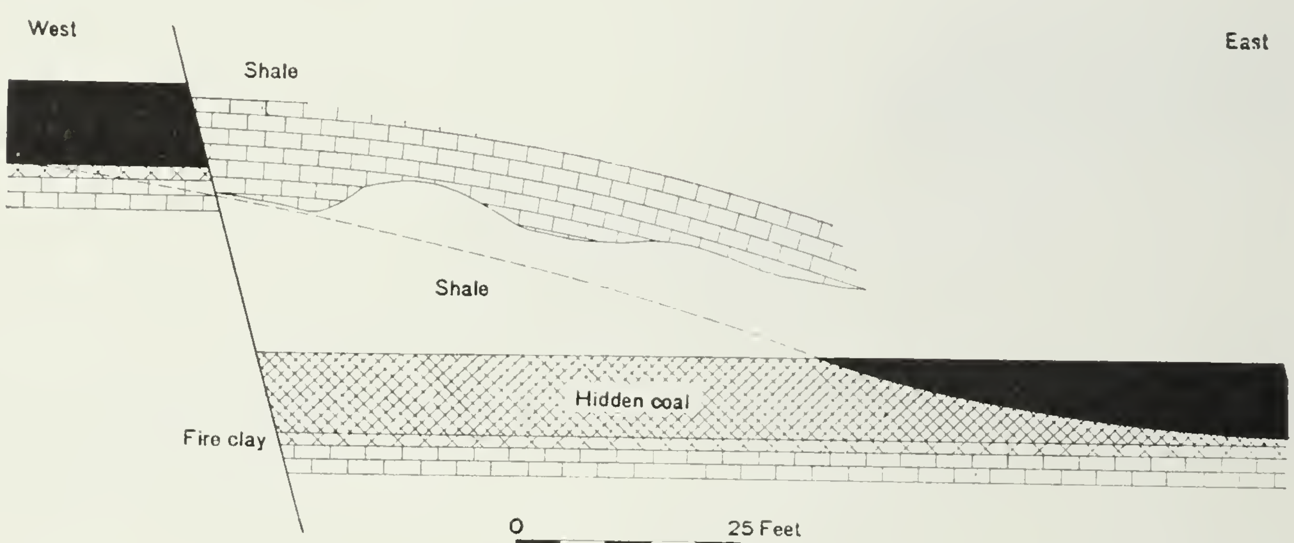


Fig. 11. Cross-section of fault in the main west entry of the mine of the Jackson Coal Company at Hallidayboro. The dashed line shows the profile of the base of the entry.

Faults near Hallidayboro.—The two main faults indicated on Plate I in the workings of the mine of the Jackson Coal Company at Hallidayboro are both of some interest. The larger fault, which is of the normal type, is shown diagrammatically in figure 11 where it cuts the main west entry about 400 feet from the shaft. The displacement in the plane of the section is approximately 30 feet.[5] It is thought that this is nearly a maximum figure for this fault, and that the throw is smaller to the northwest and southeast. At the north end of entry 9 N. off the main W. in the NE. ¼ SE. ¼ sec. 19, T. 7 S., R. 1 W., the throw of this fault is only 7 feet.

[5] Along the fault plane there is a vein of calcite about an inch thick, associated with which are numerous capillary, fibrous crystals of melanterite ($FeSO_4 \cdot 7H_2O$) a pale green mineral with a vitreous luster and a pronounced astringent, metallic taste. Both of these minerals are commonly present along the fractures found in the coal of the area.

The small fault, as indicated in figure 12, appears to be of the reverse type. This fault was probably caused by compressive forces, and its position fixed by a pre-existing roll. The roll in the coal seam on the west side of the fault is better shown in the main east entry than it is in the back east entry represented in figure 12. Along the main east entry a stringer of coal about 6 inches thick branches up from the fault plane, and there is no actual faulting along the west side of the roll, such as that indicated in figure 12 by the dotted line. The bedding of the coal within the rolled area is notably disturbed, in places appearing slightly contorted. The apparent throw of this fault is 9 to 10 feet where crossed by the main east entry. It is probably less than this to the northwest and southeast, as many rooms in the old workings were holed through it.

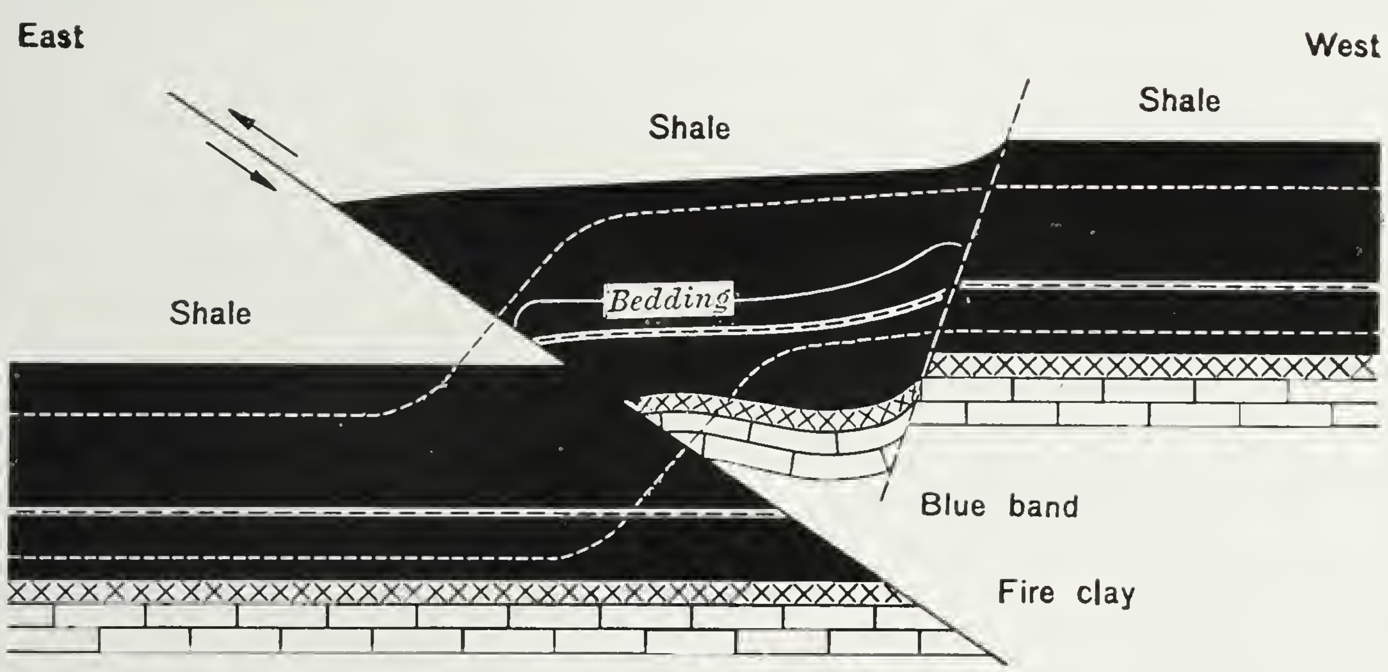


Fig. 12. Cross-section (looking south) of fault of the reverse type in the back east entry of the mine of the Jackson Coal Company at Hallidayboro. The dashed lines show the profile of the entry. Scale, 1 inch equals about 13 feet.

Faults near Dowell.—From the viewpoint of faulting, the most interesting mine in the area is the Kathleen mine at Dowell. The workings of this mine are shown in some detail on Plate II. With one exception all the faults so far discovered trend in a direction parallel to the Duquoin monoclinal flexure. They are limited to the eastern and southern parts of the workings. In the rest of the mine the coal seam has a rather uniform easterly dip of approximately 3½°. Figure 13 is a generalized cross-section of the faulted portion of the main east entry with a few minor displacements omitted. Faults Nos. 2, 5, 6, and possibly 7 have smaller displacements to the south than indicated in the figure, while the reverse is true of Nos. 1 and 4. According to recent report, fault No. 1 has a throw of 35 to 40 feet about half a mile

south of the main east entry, where No. 5 coal seam appears in the face of 9 and 10 east entries off the main south entry. Fault No. 3 has a larger displacement a quarter of a mile to the north, but still farther north it dies out rapidly. Presumably it has a smaller displacement to the south of the main east entry than is indicated in figure 13. The only other important fault so far discovered in the Kathleen mine (see Pl. II) is about 500 feet west of No. 1, but is south of the main east entry.

Figure 13 shows that the dominant faulting in the Kathleen mine is of the normal type, and that the net result of the faulting is a minor structural trough. This trough-like character dies out rapidly to the north, due to the lack of persistence of fault No. 3 along the west side. To the south the detailed conditions are unknown. West of Dowell, as well as east of the faulted area (see Plate I), the coal seam is nearly horizontal, though it does have an extremely gentle easterly dip.

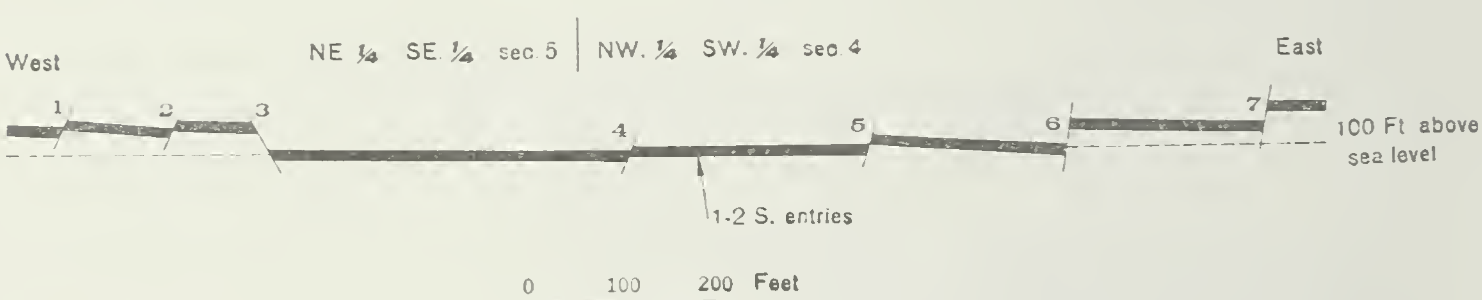


FIG. 13. Profile of faulted part of the Herrin coal seam along the main east entry of the Kathleen mine at Dowell. Fault No. 2 is not shown on Plate I.

Although the major faulting in the Kathleen mine is of the normal type, there has been some reverse faulting on a small scale, as shown by the detailed sketch (fig. 14). It seems there have been two movements here; the earlier a normal fault, the later a reverse fault. The first fault was along the plane including A-B and its now offset continuation C-E. The throw amounted to about 7 feet, with downthrow on the west side. The second fault was horizontal along B-C with a displacement of 5 feet 9 inches in a direction perpendicular to the strike of the earlier fault. It is to be noted that the plane of the second fault includes the top of the downfaulted part of the coal seam, and the "blue-band" in the other part of the seam, both of which are relatively weak surfaces. It was not possible to determine the actual directions of movement, but many of the fault planes in the Kathleen mine show apparently horizontal slickensides, as if at least in part the strata moved laterally along the fault plane.

Essentially identical relationships are seen in other parts of this mine, such as along the main east entry where it cuts faults Nos. 1 and

2. Moreover, some of the cross-sections of the larger faults show characteristics which are in harmony with these relationships. Thus in figure 15, the folding of the bedding planes in the coal indicates that compressive forces followed those which caused the typical normal faulting. Although the bedding planes in the coal on the west side of this fault plane probably once dipped down rather steeply to the east, as would have been caused by the drag of the down-dropping strata on the east side of the plane, later compressive forces presumably modified this dip, or even reversed it, as shown in figure 15. Thus the bedding of the coal seam in the upper part of the diagram near the fault plane is almost parallel to the fault plane, but the strata are

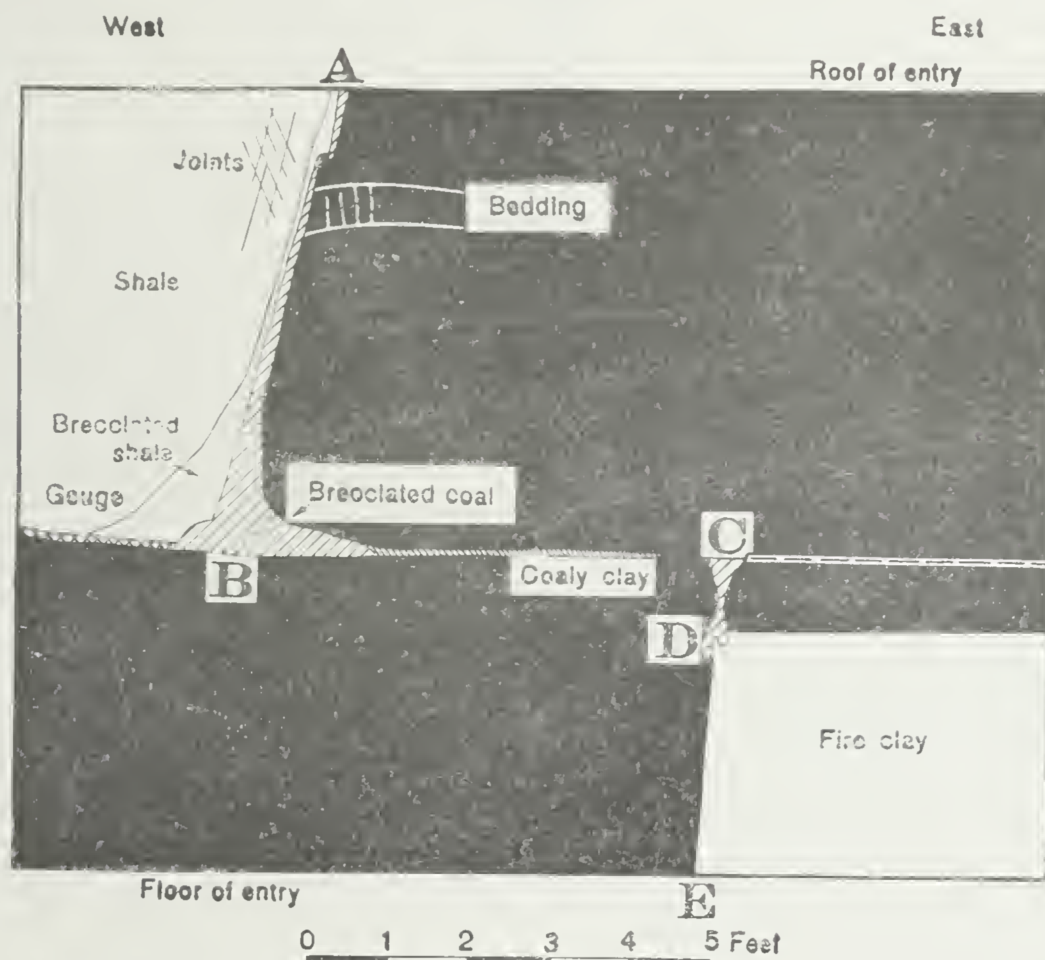


FIG. 14. Detailed sketch of fault in north rib of entry 5 W. (100 feet west of the main south) in the Kathleen mine at Dowell.

bent upwards. The maximum thickness of the gouge zone shown is about six inches, and it is made up almost entirely of shale.

Faults east of Duquoin.—The map of the abandoned Davis or Queen mine in the NW. ¼ of sec. 15, T. 6 S., R. 1 W., shows two nearly parallel faults (Pl. I) trending in about the same direction as the faults in the Kathleen mine. It seems probable that these produce a shallow structural rift, similar to the trough of the Kathleen mine (fig. 13). The west fault is the larger, and has a maximum throw near the shaft, where it amounts to about 20 feet, but decreases to about eight feet before it leaves the mine workings. The offset of

the east fault is only about 10 feet. Further data obtained on the faults in this old mine are highly conflicting, although it is known that to the south of the shaft the east fault dies out within the mine workings. From a study of the logs of available drill holes, it seems probable that the west fault extends as far south as the SE. 1/4 of sec. 21, T. 6 S., R. 1 W., as shown on Plate I.

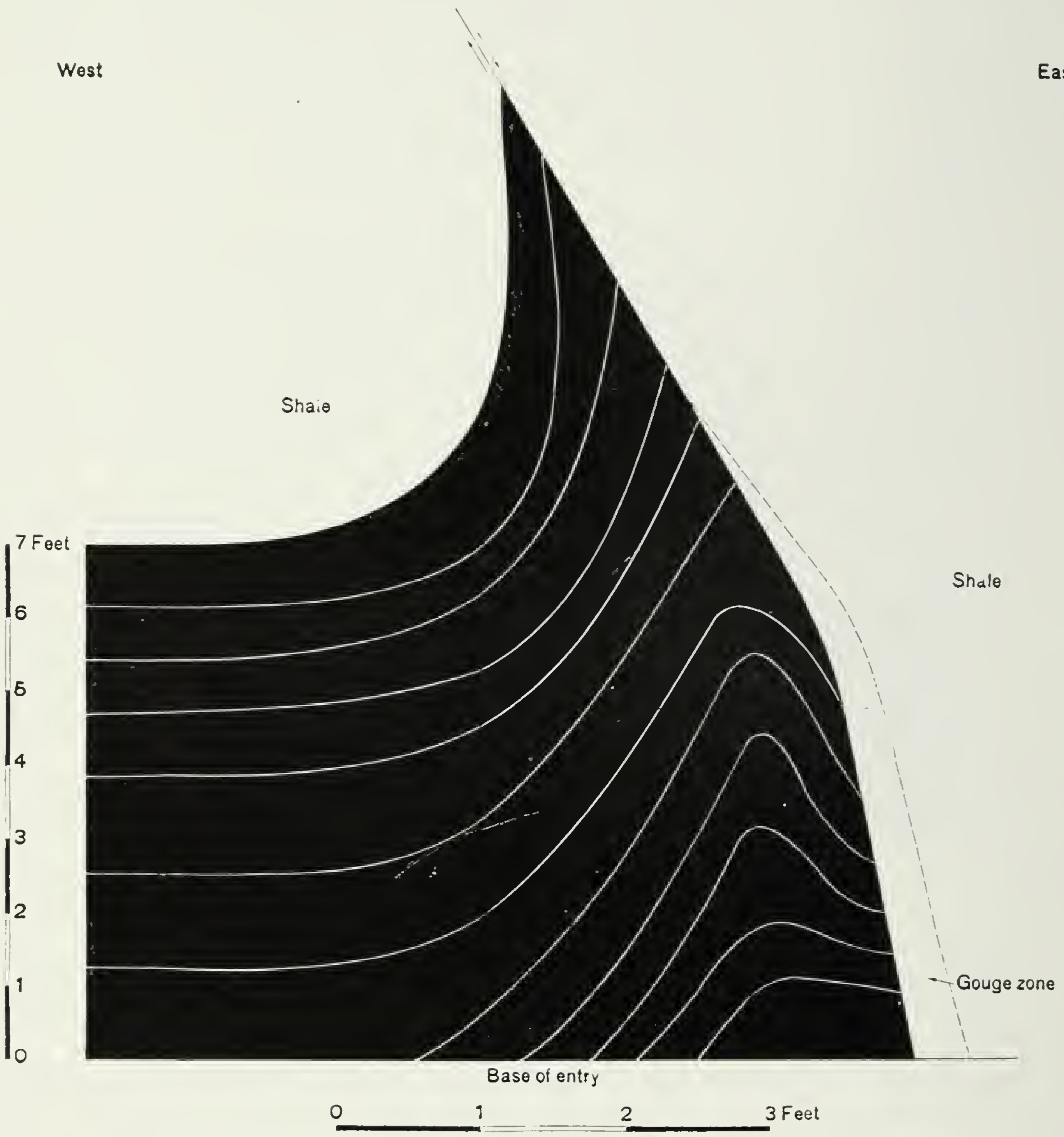


Fig. 15. Cross-section of fault No. 3 (fig. 13), north rib, main east entry, Kathleen mine at Dowell. Curved lines indicate prominent bedding planes in the coal seam.

PRACTICAL ECONOMIC ASPECTS

Value of the Structure Contour Map, Plate I

Plate I shows the lay, the continuity, and the areal limits of the Herrin coal, the approximate location and extent of certain areas of

split coal and faults whose displacements can be computed from contours on both sides of the fault lines. With the aid of the structure contours it is possible to determine the depth to the Herrin coal seam at any point where the surface elevation is known. If the coal is above sea-level its elevation as shown by contours should be subtracted from the elevation of the surface to find the depth; in case the coal is below sea-level, these two elevations should be added.

Effects of Faulting on Mining Methods at Dowell

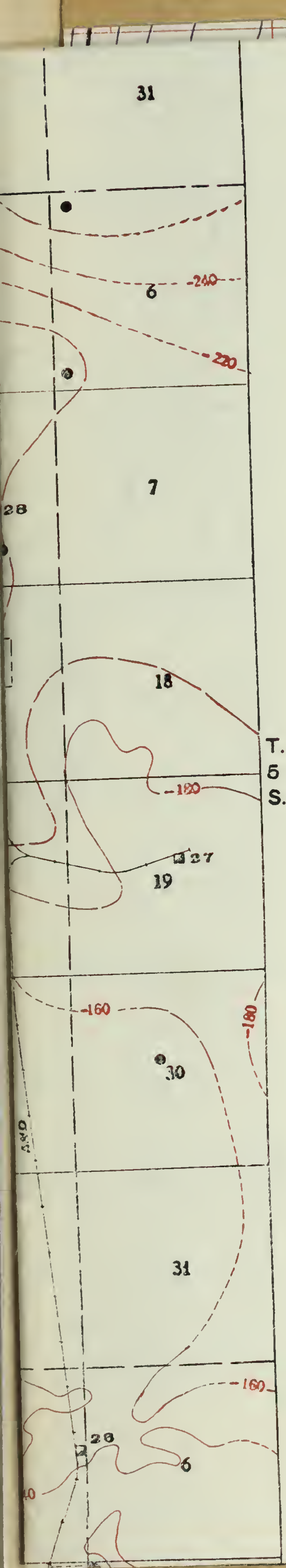
In driving the main east entry of the Kathleen mine, when fault No. 3 (fig. 13 and Pl. II) was encountered, the entry was continued sloping rather steeply to the east until it again reached the base of the seam near fault No. 4. On continuing to the east, faults Nos. 5, 6 and 7 were encountered and necessitated a rather rapid rise in the level of the entry. The result was two steep grades opposing each other along a main haulage way. Later the roof of the main east entry was shot down until the entry was nearly level between faults Nos. 3 and 7. The back east entry was not changed, however, as it was needed to remove the coal from the base of the trough. Entries driven north and south from the back east entry at the base of the trough are used for the removal of the low coal. The south entry was driven slightly west of south to parallel the faults.

Entries running west from entry 1 south off the back east can be continued across the trough and reach coal No. 5 with no pronounced change in level. Thus if in the future it is desirable to mine this lower seam, it can be done without deepening the shaft.

Importance of Drilling

Before the shafts of prospective new coal mines are started, it is economical to ascertain the conditions affecting the coal seam by drilling. Along the faulted belts previously described (p. 25), or in the areas outlined on Plate I as being underlain by split coal, core-drilling is highly desirable. Sufficient holes should be put down to leave no doubt about the character, continuity and attitude of the coal. Where the coal seam is split, drill cores would show the thickness and characteristics of the interbedded shale. An operator should be competent to pass on the desirability of the prospective location from this point of view. Where a seam is not essentially horizontal and is faulted, more holes might be necessary, and it would be advantageous to the prospective operator to have an experienced geologist in consultation to advise on the locations of holes and the interpretation of the struc-

ture from the cores. With careful, thorough work it would be possible to locate a fault where the throw was large enough to be a very important factor in mining;—that is, greater than 10 or 15 feet. Where the coal seam is not split, and the strata are essentially horizontal, churn drill holes would probably give satisfactory information with regard to depth and continuity of the coal and location of faults.



Downthrow side of fault.

Shipping mine, entrance by shaft.

Shipping mine, entrance by slope.

Strip pit.

Local.

Abandoned.

Drill hole.

Structure contours drawn on the base of the Herrin (No. 6) coal with reference to sea level.

Certain.

Doubtful.

Problematical.

LIST OF SHIPPING MINES IN THE AREA

(Active or only temporarily idle in 1923)

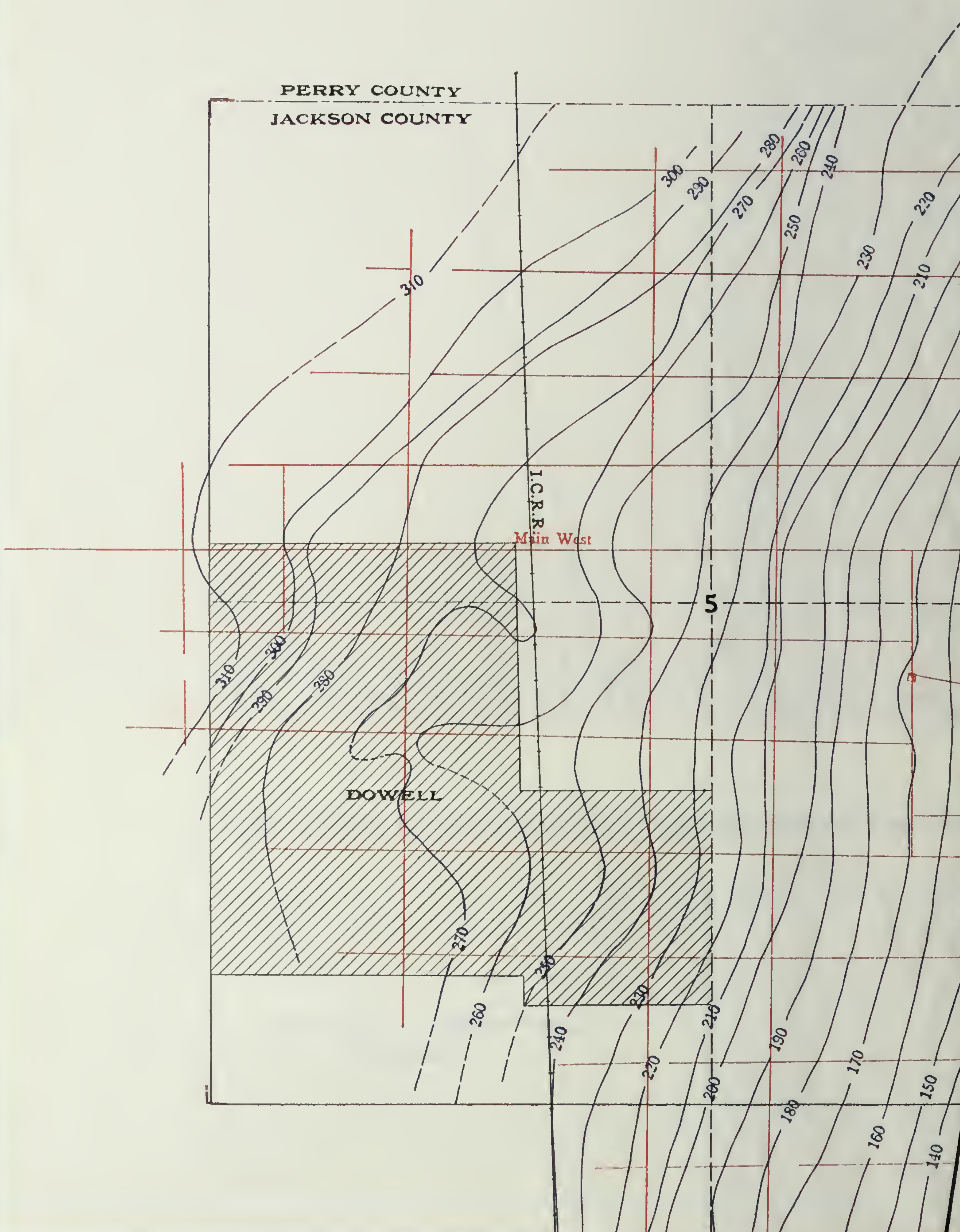
Map No.	Town	Company	Mine No. or Name
		WASHINGTON COUNTY	
1	Bois	Kuhn Colliery Co.	
		PERRY COUNTY	
2	Tamaroa	Victory Colliery Co.	
3	Tamaroa	Little Muddy Fuel Co.	
4	Sunfield	Bailey Bros. Coal Co.	Diamond
5	St. John		
6	St. John	Gayle Coal Co.	Strip pit
7	Duquoin	Paradise Coal Co.	Paradise
8	Duquoin	Equitable Coal and Coke Co.	Majestic
9	Duquoin	Scott-Smith Co.	Strip pit
10	Duquoin	Jewel Coal Co.	No. 1
11	Duquoin	Jewel Coal Co.	No. 2
12	Duquoin	Rutledge and Taylor Coal Co.	Security
		JACKSON COUNTY	
13	Dowell	Union Colliery Co.	Kathleen
14	Elkville	Black Servant Coal Co.	Strip pit
15	Hallidayboro	Jackson Coal Co.	No. 1
16	Ward	Midway Coal and Mining Co.	No. 1
17	Ward	Jackson Peacock Coal Co.	Slope mine
18	Hurst	Bradbury-Scullion Coal Co.	Slope mine
		FRANKLIN COUNTY	
19	Bush	Western Coal and Mining Co.	No. 2
20	Royalton	Franklin County Coal Co.	North mine
21	Zeigler	Bell and Zoller Mining Co.	Zeigler, No. 2
22	Zeigler	Bell and Zoller Mining Co.	Zeigler, No. 1
23	Christopher	Old Ben Coal Corporation	No. 12
24	Christopher	Old Ben Coal Corporation	No. 10
25	Christopher	Old Ben Coal Corporation	No. 11
26	Valier	Valier Coal Co.	No. 1
27	Sesser	Old Ben Coal Corporation	No. 16
28	Sesser	Southern Gem Coal Corporation	No. 2
		WILLIAMSON COUNTY	
29	Weaver	Old Ben Coal Corporation	No. 20

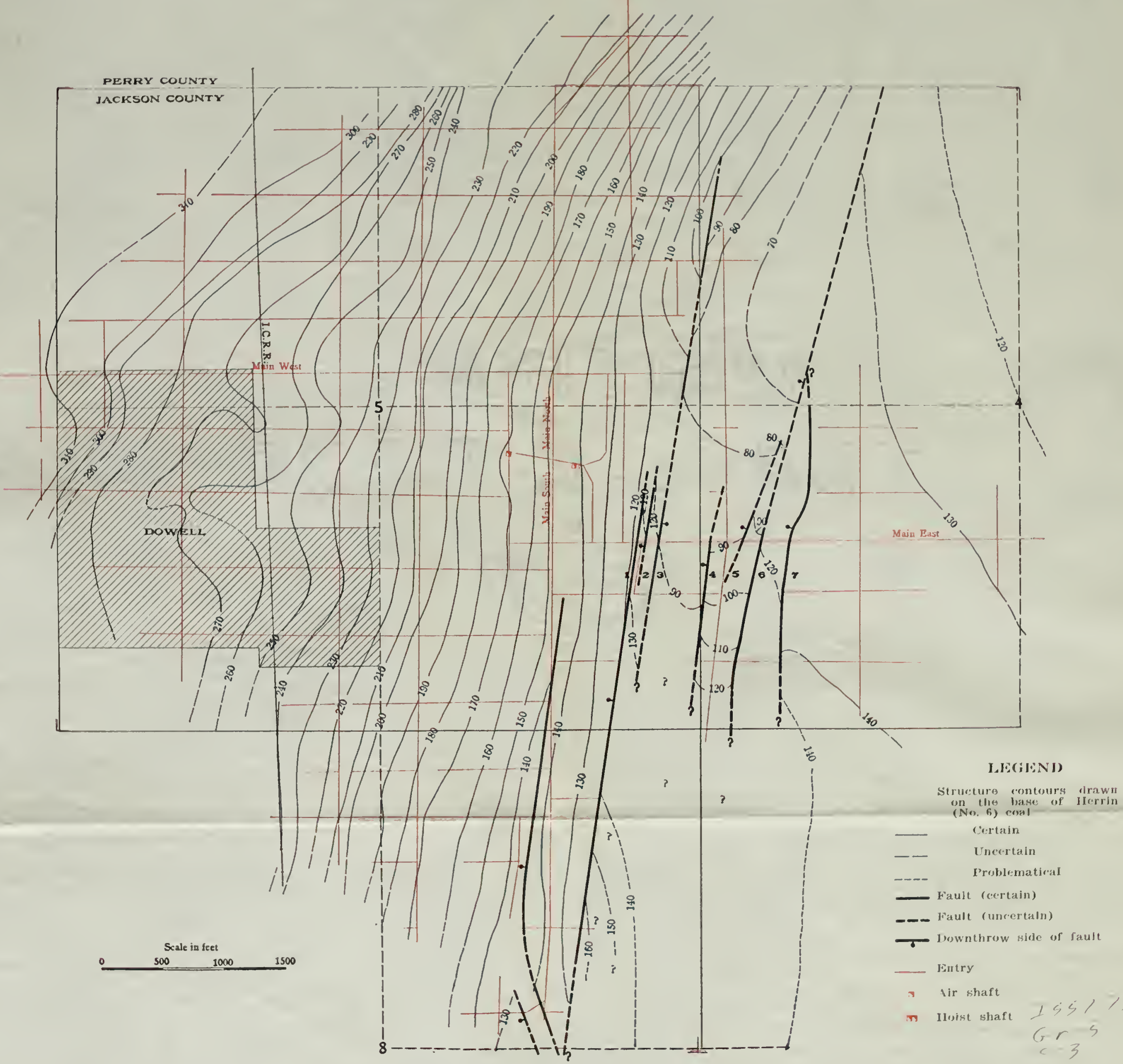
LIST OF SHIPPING MINES IN THE AREA

(Active or only temporarily idle in 1923)

Map No.	Town	Company	Mine No. or Name
		WASHINGTON COUNTY	
1	Bois	Kuhn Colliery Co	
		PERRY COUNTY	
2	Tamaroa	Victory Colliery Co.	
3	Tamaroa	Little Muddy Fuel Co.	
4	Sunfield	Bailey Bros. Coal Co.	Diamond
5	St John		
6	St John	Gayle Coal Co	Strip pit
7	Duquoin	Paradise Coal Co	Paradise
8	Duquoin	Equitable Coal and Coke Co.	Majestic
9	Duquoin	Scott Smith Co	Strip pit
10	Duquoin	Jewel Coal Co	No 1
11	Duquoin	Jewel Coal Co	No 2
12	Duquoin	Rutledge and Taylor Coal Co	Security
		JACKSON COUNTY	
13	Dowell	Union Colliery Co	Kathleen
14	Elkville	Black Servant Coal Co	Strip pit
15	Hallidayboro	Jackson Coal Co.	No 1
16	Ward	[illegible] Coal and Mining Co	No 1
17	Ward	Jackson Peacock Coal Co	Slope mine
18	Hurst	Bradbury Southern Coal Co	Slope mine
		FRANKLIN COUNTY	
19	Bush	Western Coal and Mining Co	No 2
20	Royalton	Franklin County Coal Co.	North mine
21	Zeigler	Bell and Zoller Mining Co.	Zeigler No 2
22	Zeigler	Bell and Zoller Mining Co.	Zeigler No 1
23	Christopher	Old Ben Coal Corporation	No 12
24	Christopher	Old Ben Coal Corporation	No 10
25	Christopher	Old Ben Coal Corporation	No 11
26	Valier	Valier Coal Co	No 1
27	Sesser	Old Ben Coal Corporation	No 16
28	Sesser	Southern Gem Coal Corporation	No 2
		WILLIAMSON COUNTY	
29	Weaver	Old Ben Coal Corporation	No 26

Map of the Duquoin area showing faults, structure of the base of the Herrin (No. 6) coal, and distribution of the Herrin coal.


PERRY COUNTY
JACKSON COUNTY
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
I.C.R.R.
Main West
5
DOWELL
Main South
Main North



Map of Kathleen mine, Union Colliery Company, showing faults and structure contours on Herrin (No. 6) coal, secs. 4, 5, and 8, T. 7 S., R. 1 W.